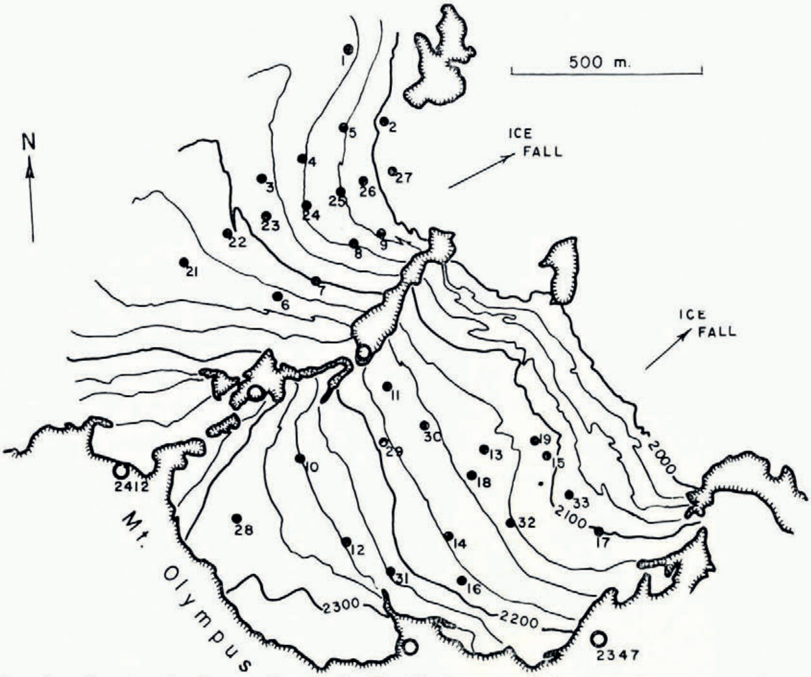

Fig. 2. Location of 32 long-term ice flow markers in the Blue Glacier accumulation zone. Contour interval is 25 m. This topographic sketch map is derived from American Geographical Society Special Publication No. 34, "Nine glacier maps: northwestern North America", Sheet No. 2, Blue Glacier

(s = 37 cm.) has been placed in the Olympic National Park museum (U.S. National Park Service) in Port Angeles, Washington.

Marker construction material is stainless steel strip of cross-section 50 mm. × 2·8 mm. (2″ × $\frac{1}{8}$″). Each strip is twisted 1$\frac{1}{2}$ times and the ends are joined to form an equilateral triangle. This configuration was chosen to provide maximum stability of position once incorporated in the ice, and as an unusual shape which would attract an observer's eye when the markers reappear.

The markers are all in a zone of heavy annual accumulation where they will rapidly become buried in firn, and eventually in glacier ice. Their reappearance on the lower part of the glacier years hence is expected to yield valuable information on flow lines and velocities deep in an active glacier. It is hoped that future glaciologists will be encouraged by this present notice to recover these markers and identify the flow lines.

Copies of this notice are being filed with the National Park Service and with the University of Washington archives, together with other pertinent data which include a topographic map showing the 1963 marker sites and the compass bearings from these sites to fixed reference points.

Department of Atmospheric Sciences,
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Seattle 5, Washington, U.S.A.
25 September 1963

E. LaChapelle

Sir,

Glacial benches in south Victoria Land

In a recent letter McGregor (1963) questioned our interpretation of benches that occur at 1,200–1,500 m. (and at other elevations) on the sides of the Wright and Victoria Valleys (Bull and others, 1962). We have interpreted the "benches" as having been carved by glaciers broader, shallower and higher than those which later cut the deeper U-form of the present valleys. However, McGregor considers that the benches are solely structural in origin and have been formed by differential erosion at the sandstone–dolerite, sandstone–basement or dolerite–basement contacts.

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We agree with McGregor that the resistant dolerites form flat benches and terraces and that the sills exercise control over the topography, so that often benches are structurally controlled (McKelvey and Webb, 1959, p. 722).

However, in many places, benches are not structurally controlled. At the eastern side of Bull Pass a well-preserved bench (Bull and others, 1962, fig. 5) lies below the dolerite–basement contact. In the western part of the Olympus Range (Bull and others, 1962, fig. 6, extreme left) the bench is cut in basement rocks far below the base of an overlying dolerite sill. The surface of the Labyrinth (Bull and others, 1962, fig. 3) does not coincide with a dolerite–basement or sandstone–basement contact.

Fig. 1. Glacial benches in south Victoria Land

Figure 1 illustrates the relation between the lithology and the benches in the south-east part of Wright Valley. On the south side of the valley (right of the photograph) one bench is carved entirely within the basement, where the structure is so complex that it can have afforded no control to the altitude or attitude of the bench. On the south side of Dais (centre of Figure 1) a bench at the same height is cut below the dolerite–basement contact. Other benches on Dais (left of Figure 1) are cut entirely within the dolerite sheet.

Other photographs of the area, already published, also show benches which are not structurally controlled (Webb and McKelvey, 1959, figs. 5 and 11).

We realize that much caution must be used in interpreting such glacially carved benches as being remnants of the glacier floor at an earlier stage. Many authorities have so interpreted them, for example, Hobbs (1911), Matthes (1930), Thornbury (1954) and Cotton (1958), but the problem is far from being settled. Matched pairs of benches occur on the sides of the Wright Valley and the elevation of some of them at least is unrelated to structure. The cross-section of the valley in the area of Dais shows a pronounced U-in-U form, the uppermost U being defined by the highest benches on the valley sides and by the top of Dais. We have considered it unlikely that the shoulders of these benches would remain so well preserved if the benches were cut by a glacier which simultaneously occupied the deeper-cut central part of the valley. Hence we have interpreted the benches as indicating levels at which broader glaciers stood for a considerable period.

Since we wrote the first draft of this letter, the Editors of the *Journal of Glaciology* have brought to our attention a further criticism by Gunn (1963).

Gunn's suggestion that the "first glaciation benches" coincide with the top of the Peneplain Sill is covered by our remarks above.

We do not agree that the material in the South Fork can be called "an almost stagnant glacier" and do not understand Gunn's criteria for this interpretation. Amongst other considerations, the weathering and stability of this moraine are very much greater than those of the ice-cored moraines at the eastern end of the valley and elsewhere in the ice-free area.

The marked difference in the weathering of this moraine and of the older "third glaciation moraine" farther east justifies our distinction between the "third" and "fourth" glaciations as we have defined them. Gunn suggests that, following the severance of an ice mass in the South Fork from its supply area (the present Upper Wright Glacier) the front of the isolated ice has retreated from the "third glaciation" moraines to the position shown in Gunn's figure 1. The gradual ablation of a starved ice mass could not account for the sharp demarcation line between the older and newer moraines, nor for the lobate shape illustrated. Our interpretation, that the "third" and "fourth glaciation moraines" are associated with separate advances of tongues from the inland ice, is fully compatible with the present field evidence.

Since 1959 much work has been done in the ice-free valleys. At present the picture we have given as a result of our reconnaissance seems to remain substantially acceptable. However, the interpretation of some observations has already been changed (Nichols, 1961, 1962; Bull, 1962; Calkin and Cailleux, 1962) and considerable modifications, especially in the Victoria Valley system, have resulted from the work of Parker Calkin, Institute of Polar Studies, The Ohio State University, which will be completed and published in the near future.

We are grateful to Parker Calkin and other members of the Institute of Polar Studies for discussions on the subject. This letter has been written while one of us (Colin Bull) is engaged on National Science Foundation Grant G–20473.

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24 June 1963

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Sir, *Dielectric measurements on Antarctic snow at 3,000 Mc./sec.*

During the University of Michigan's Ross Ice Shelf survey expedition 1962–63, I had the opportunity of making some measurements of the coefficient of refraction, the dielectric constant and the loss factor of snow from the surface to a depth of 3 m. at a frequency of about 3,000 Mc./sec.

In order to measure the coefficient of refraction, the transit time of a 3,000 Mc./sec. wave below the snow surface was measured over distances of between 50 m. and 1,000 m. The results of these measurements have been checked by measurements of the dielectric constant and the loss factor of snow samples placed in the propagation space in a cavity resonator. Density, structure and temperature of the snow samples have also been measured.

A preliminary interpretation, taking account of temperature, shows that the dielectric constant increases from 1·6 to 1·9 with the depth and snow density, and also reveals a clear variability of wave propagation caused by ice layers in the snow. It seems possible to modify the measuring method so that it may be used to determine snow density, to locate ice layers, and to give quantitative measurements of snow drift (the amount of snow being transported in a given cross-section). I hope it will be possible to continue these experiments during further expeditions.

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